**MIDDLE EAST TECHNICAL UNIVERSITY**

**ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT**



**EE463 STATIC POWER CONVERSION-I**

**PROJECT #2 REPORT**

**Due Date: 16.12.2018**

**Team Members**

**Ali AYDIN 2093326**

**Furkan TOKGOZ 2031458**

**INTRODUCTION**

**Question 1-)**

**Part a-)**

1. Fully Controlled Rectifier

To calculate firing angle, we need a formula and we know that formula from courses.

(1)

Where Vs = 230 Vrms, w = 2f, f = 50, Hz, Ls = 0.5 mH and Id = 40 A.

We know above values but we do not know Vd and α. To find Vd, we can write voltage equation and that is

(2)

We know that average voltage of inductor in a period is zero. Then, Vd is equal to VR and Vd is 40\*4 = 160 V.

When we use equation 1, we find α as 41 degree. For that angle, average current is 38.25 A.

1. Half-Controlled Rectifier

Calculation of the output average voltage is straight forward.

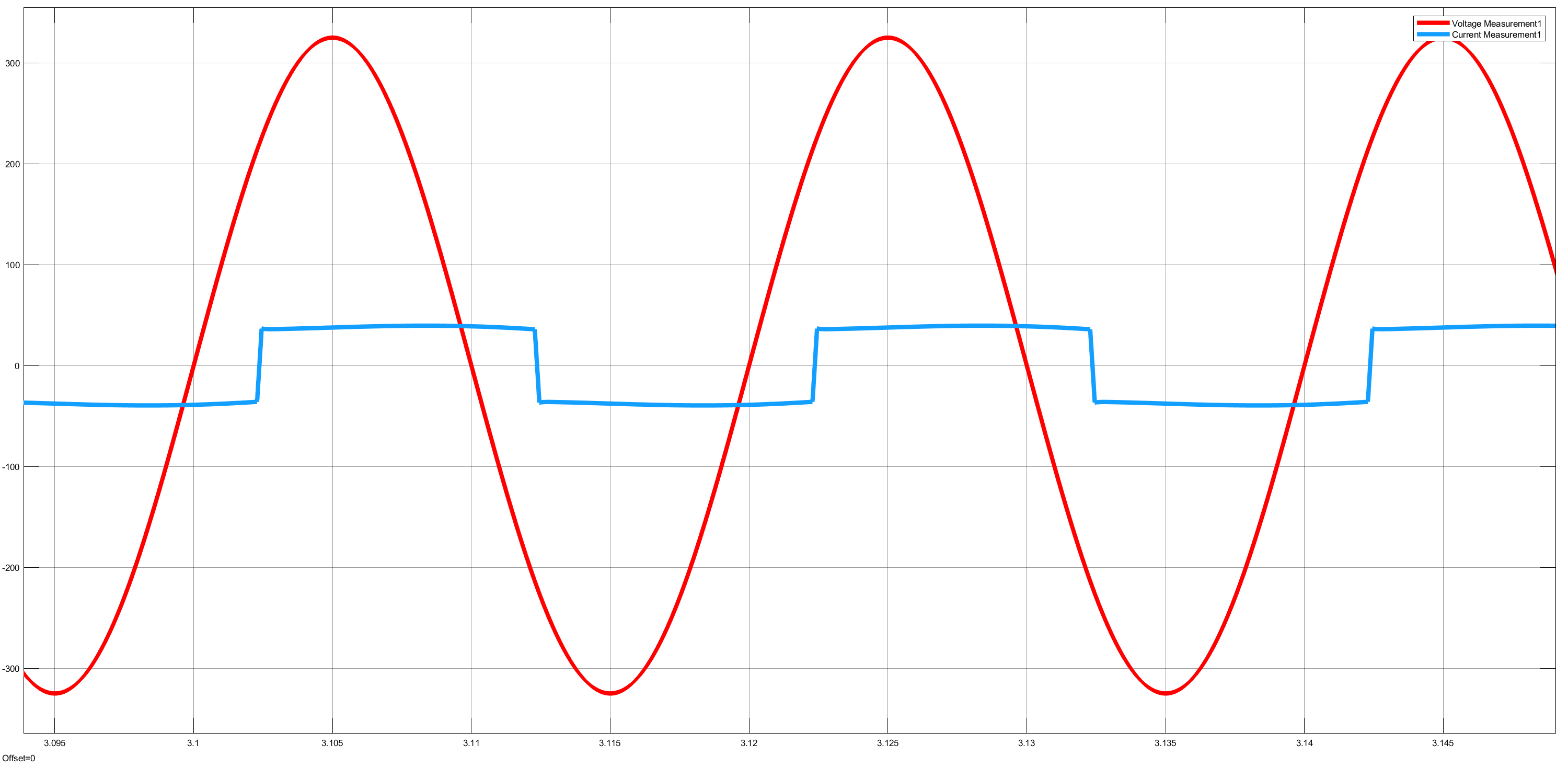
(3)

The only unknown in this equation is Vd which we have calculated as 160 V in the first part. So, α is equal to 57 degrees while Vs is equal to 230 V. We have found the average current 39.52 A for a firing angle of 57 degrees.

**Part b-)**

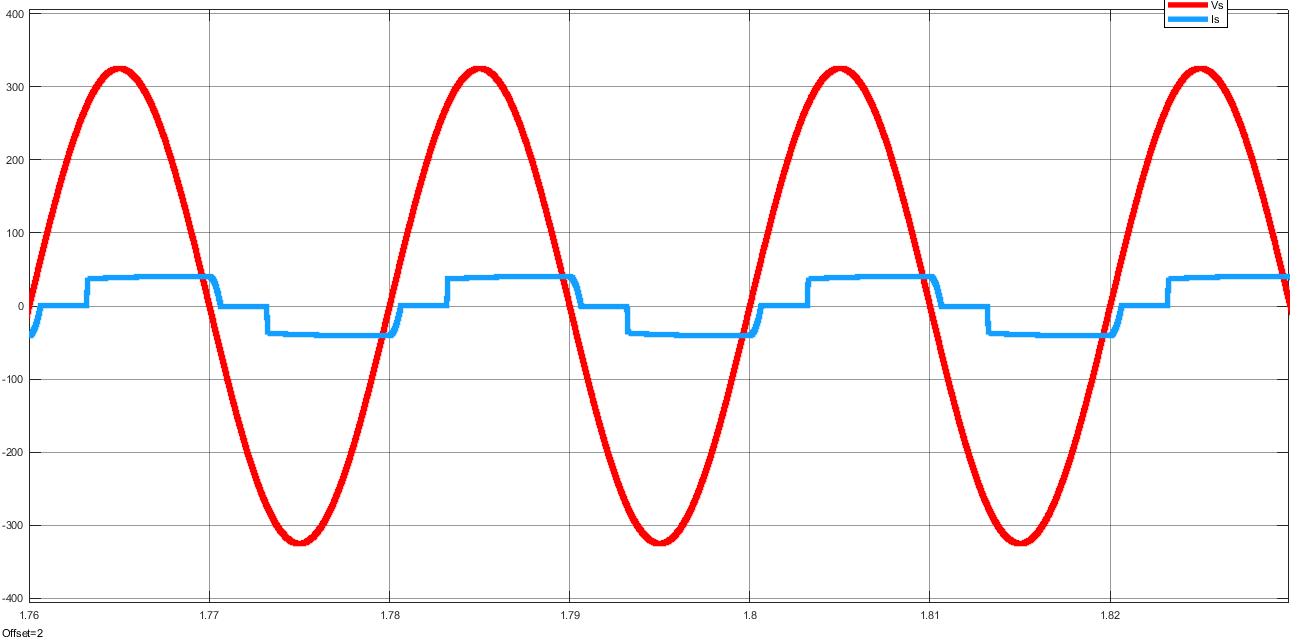
1. Fully Controlled Rectifier

We found the THD is %43.65.



1. Half-Controlled Rectifier

For half-controlled topology, THD is found as %25.85.

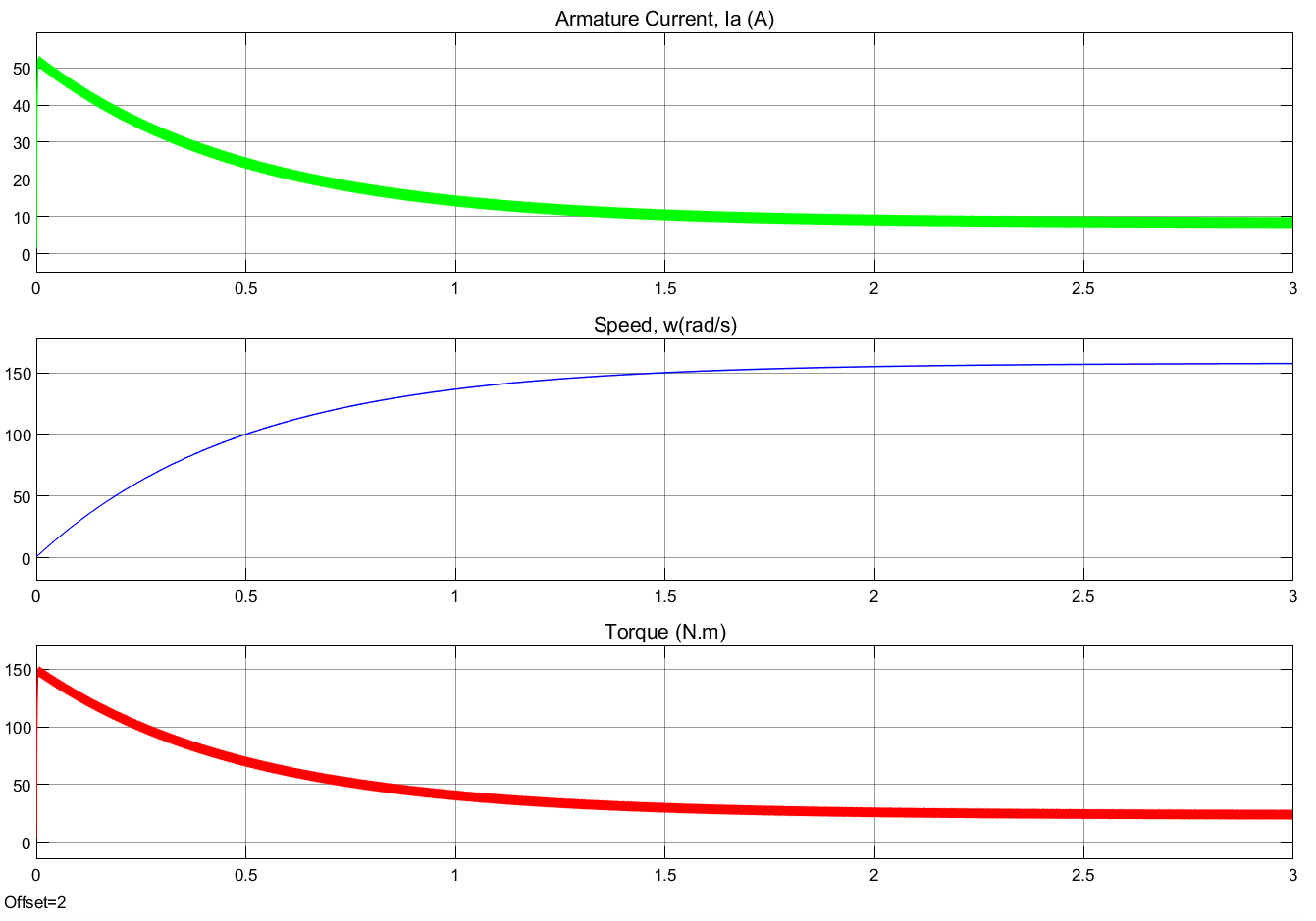


c)

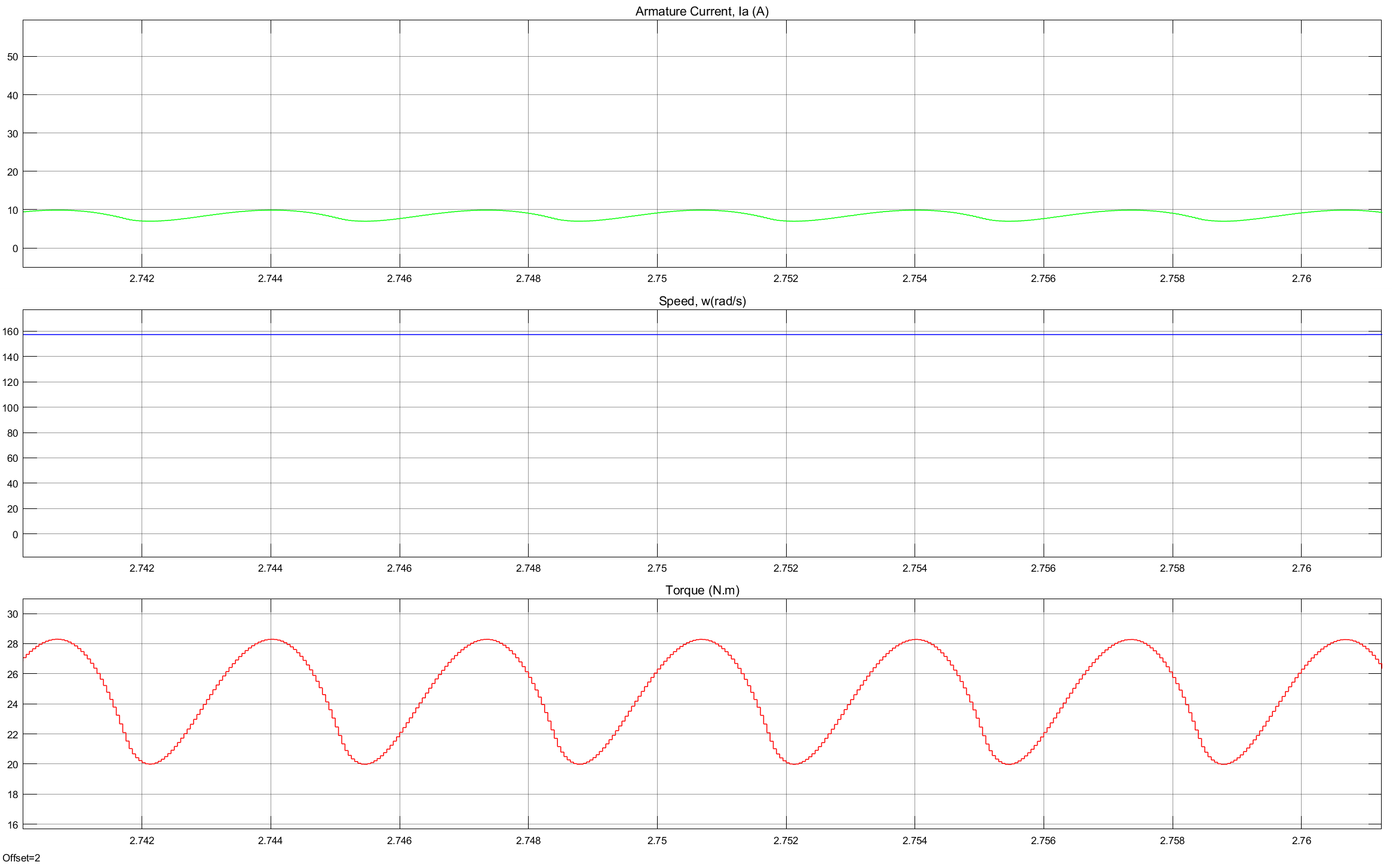
Both topologies have some advantages and disadvantages. Fully-controlled rectifiers can be operated in both quadrants whereas half controlled rectifiers cannot since diode is a single quadrant element. However, fully- controlled rectifiers can be expensive because, one should use 4 thyristors and their controllers. Also, this configuration can be hard to implement. Half- controlled rectifiers, on the other hand, uses 2 thyristors. This means it is cheaper than using fully-controlled rectifiers. However, if we set up the half-controlled rectifier as in the figure, we may end up with burnt diodes as a result. As, conducting diodes has a very small resistance, connecting them in series without a resistor may result in overcurrent in that branch.

**Question 2-)**

**Part a-)**



**Part b-)**

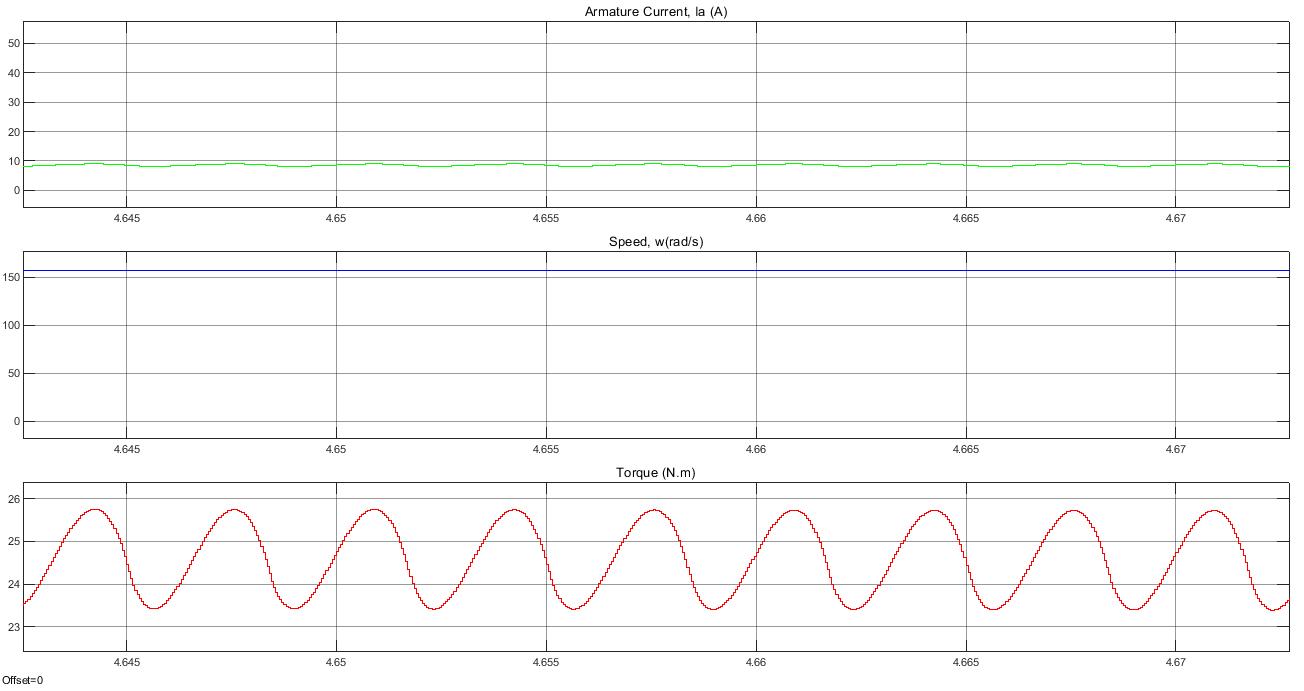
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Torque ripple is variations in torque production during revolution of shaft and this is undesirable effect since it prevents smooth motor rotation. It occurs when constant current is applied to rotate motor. Therefore, we have seen in the figure XXXX, torque is sinusoidal and its frequency is 300 Hz. Also, its magnitude is 28 N.m and its peak to peak value is 8 N.m.

Line current THD is found as %31.58 at steady state.

**Part c-)**

The first solution we came up with is connecting an inductor to the output of the rectifier. Since torque directly proportional to the armature current, in order to decrease torque ripple we should decrease current ripple. We have connected 50 mH inductor and the resultant torque graph can be seen in Fig.X.



**Part d-)**

Pout = 3853 W

Pin = 4635 W

**Question 3-)**

**Part a-)**

The name of the topology is 12 pulse rectifier. There is a transformer with two separate secondary windings. This enables us to acquire 6 different voltages with 60 degrees phase shift. After getting 6 voltages with different phases, the next step is to rectify them via diodes or thyristors. In the output voltage, we will have a rectified voltage with smaller ripple voltage compared to 3 phase rectifiers. If we keep increasing number of phases to 12, 24 or 48, we will end up with smaller ripple voltages at output side. These kinds of pulse rectifiers are used in HVDC transmission systems. These systems need to convert high voltage AC to DC. Since using DC link capacitors to filtering ripple at output voltage at these high voltages is not feasible, increasing the number of pulses is a more efficient solution to this problem.

**Part b-)**